



# How to play it safe in a lab

## Basic Course

Dr. Silke Kiesewetter, SSHE, CABS

Dr. Ines Raabe, SSHE, CABS

Anne K. Thomas, SSHE, Training

# Program

- Main hazards in a chemical laboratory
- Risk analysis - Where to find information
- Basic rules / protective measures
- Emergencies
- Questions

# MAIN HAZARDS (I): CHEMICAL PRODUCTS



# Chemical products in everyday life / at work

Chemicals can be found almost everywhere, e.g.:

- cleaning agents
- solvents
- in batteries
- in medical products / drugs
- fuels
- etching of printed circuit boards
- matches
- photography
- ...



## But: Chemicals are also hazardous...



- *fires*
- *burns*
- *chemical burns*
- intoxications
- allergies
- explosions
- *damages of skin or tissues*
- *damage of materials*
- danger for the environment



# Hazard and safety indications on lab doors

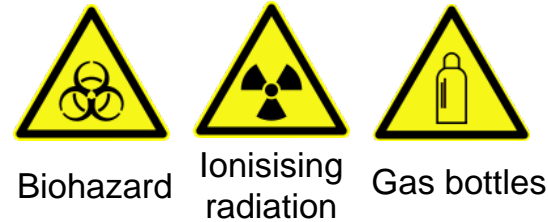


# Labels and signs



Hazard symbol, e.g. on cans

black on red / white



Biohazard

Ionising  
radiation

Gas bottles

Warning sign, e.g. on doors, cabinets

black on yellow



Fire protection signs

white on red



Rescue sign

white on green



Obligations, e.g. on doors, machines

White on blue

# Signs on Cabinets



# New GHS signs



oxidizing



corrosive



irritating, narcotic,  
allergenic



explosive



gas under  
pressure



harmful for  
environment



flammable



toxic, (oral,  
dermal,  
inhalative)



harmful, chronic  
toxicity, CMR

Source (pictures): BG RCI

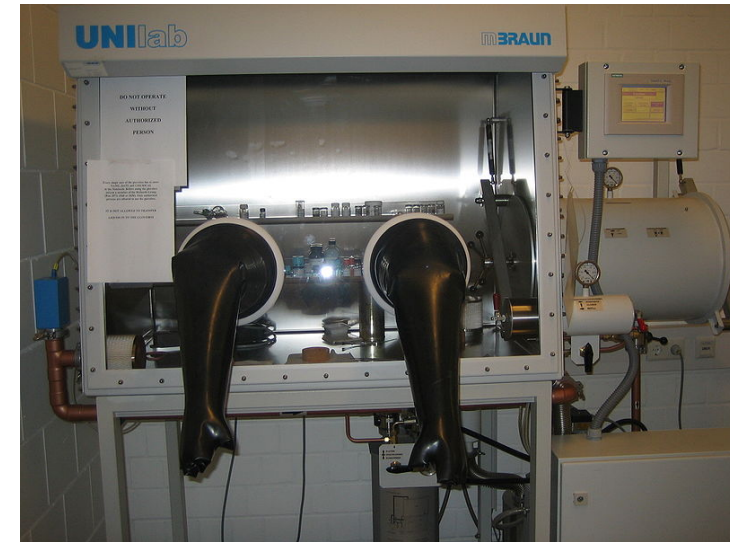
# Fume hood, glove box, laminar flow box



source: <http://www.waldner-lab.de/de/service/galerie/fotos.aspx>



source: <http://ssfp.unileoben.ac.at/Laminar.htm>



source: <http://en.wikipedia.org/wiki/File:Glovebox.jpg>

# Fume hoods

## Why working in a fume hood?

- Prevent toxic, harmful, or corrosive gases, vapors, dust particles, aerosols, etc. from spreading into the ambient air
- Prevent formation of explosive gas mixtures inside a fume hood
- Protection against splashes and splinters

## When working in a fume hood?

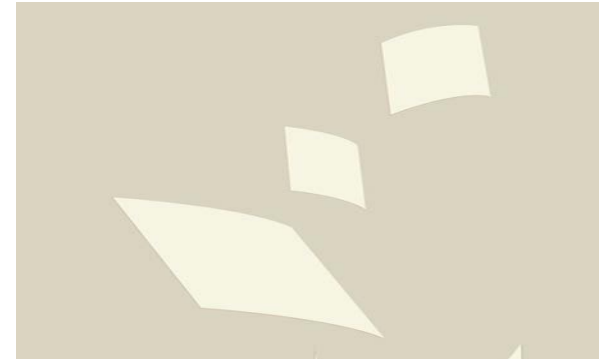
- When conducting experiments/procedures which might release harmful or hazardous gases, vapors, dust and aerosols



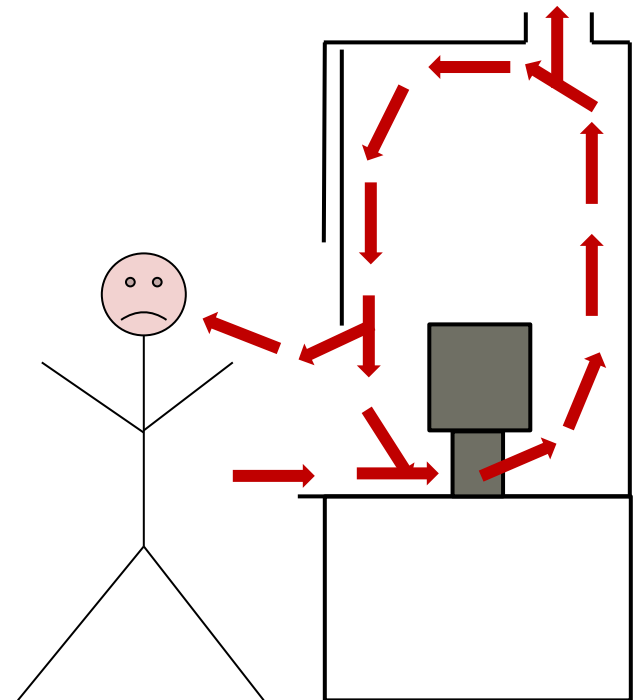
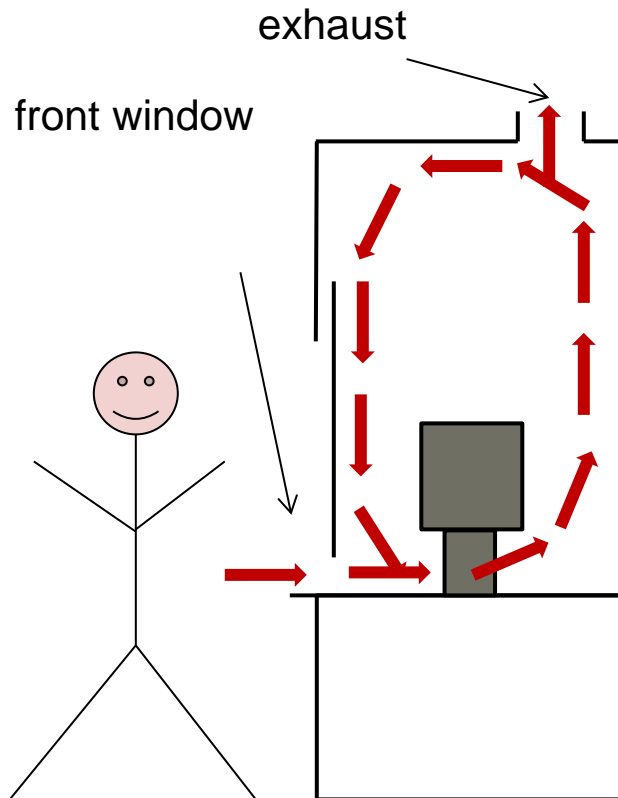
# Fume hoods

## Some basic rules:

- Check fume hood is **ON** (with a piece of paper)
- Only work in laboratory scale
- Always wear safety glasses, labcoat (and gloves)
- Keep front window closed
- Fume hood  $\neq$  storage place

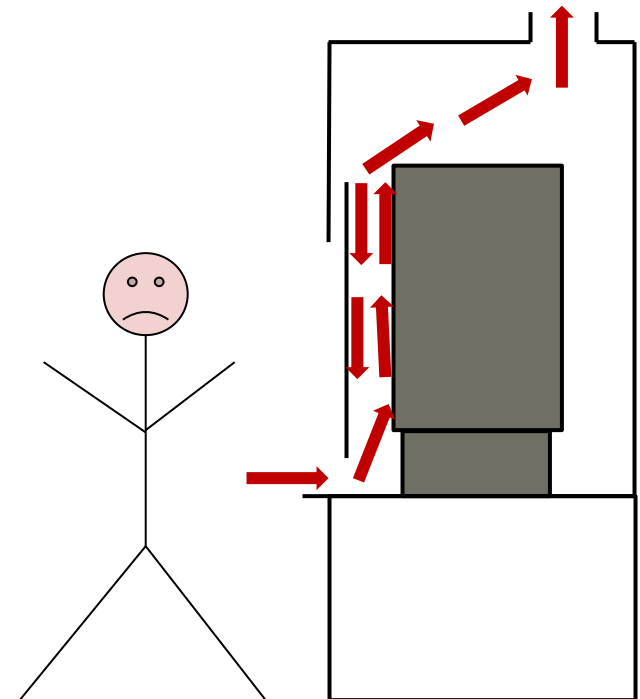
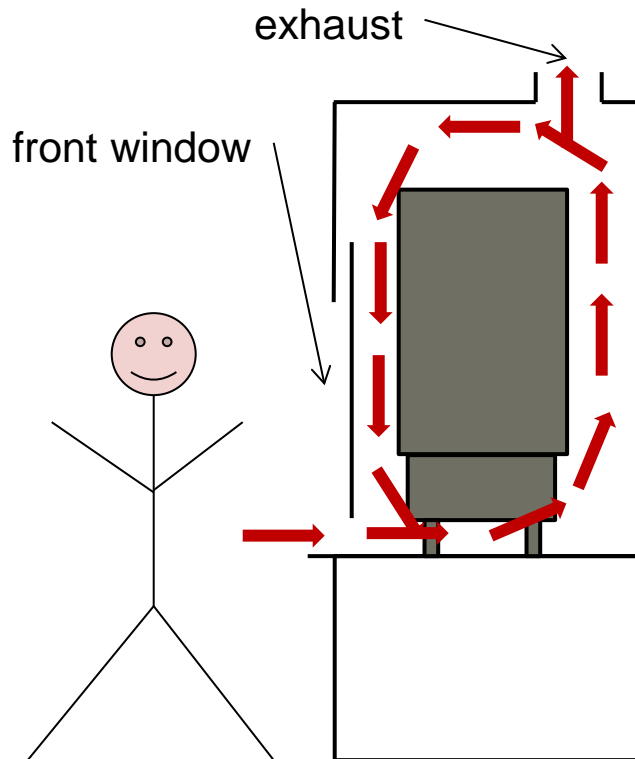


# Fume hoods



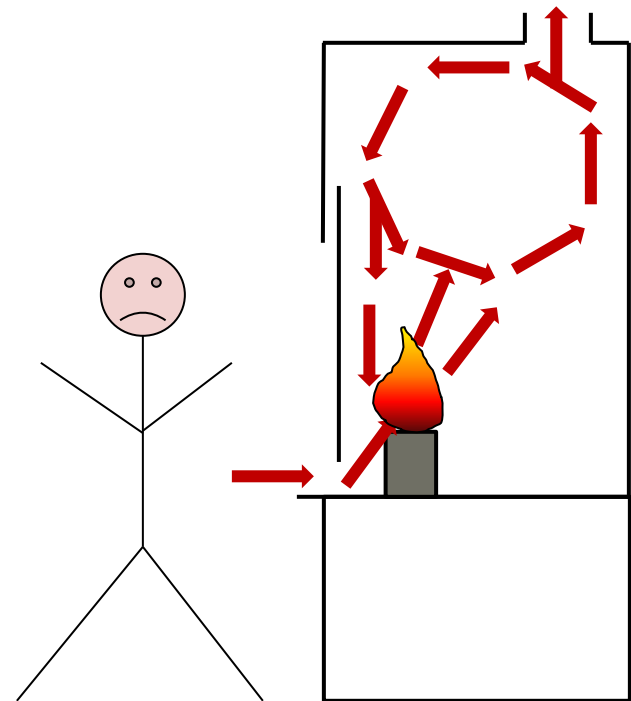
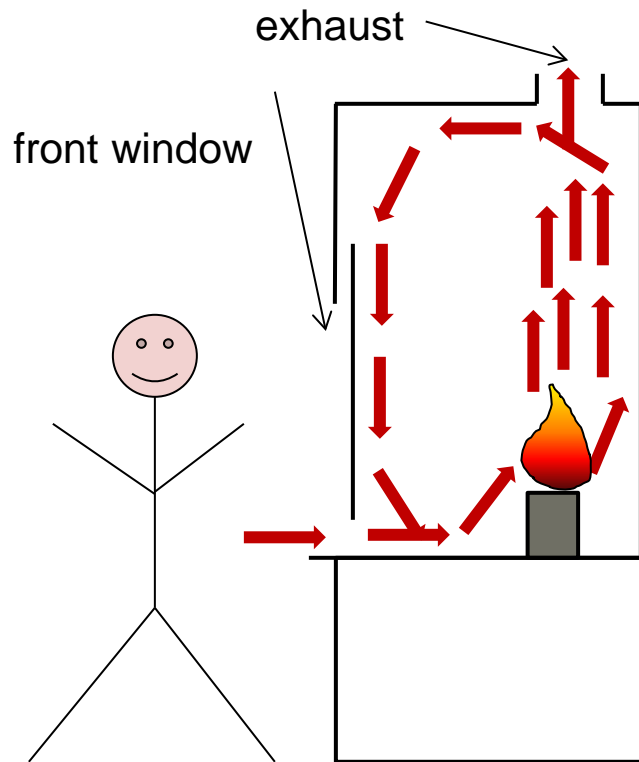
**Keep front window closed!**

# Fume hoods



**Make sure that airflow / circulation is not disturbed by large equipment in the fume hood !**

# Fume hoods



**Place heat sources in the rear part of the fume hood!**

# What is wrong?



# Glove box

## What is a glove box?

- Sealed container to manipulate compounds / objects in a separate atmosphere
- Objects / substances have to be introduced into and removed via an air-lock

## When working in a glove box?

- To work with hazardous substances in a specially filtered atmosphere
- To manipulate substances in an inert gas atmosphere (e.g. argon, nitrogen)



# Laminar flow box

## Functional principle:

- Room air is sucked in the laminar flow box and filtered (e.g. HEPA-filtration)  
→ creation of a sterile atmosphere
- Laminar flow reduces turbulences of particles present in air and discharges them downward
- Recirculation of air within the box to the room

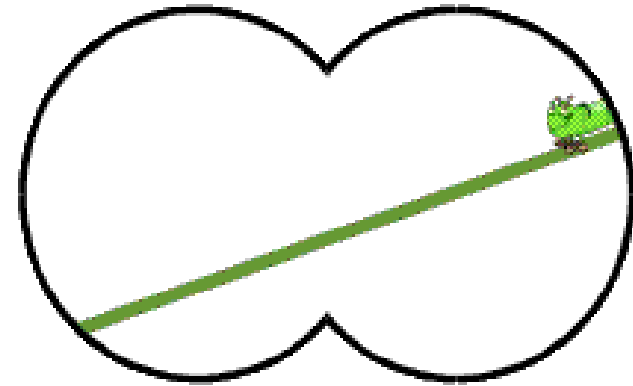
→ **Laminar flow box ≠ fume hood**



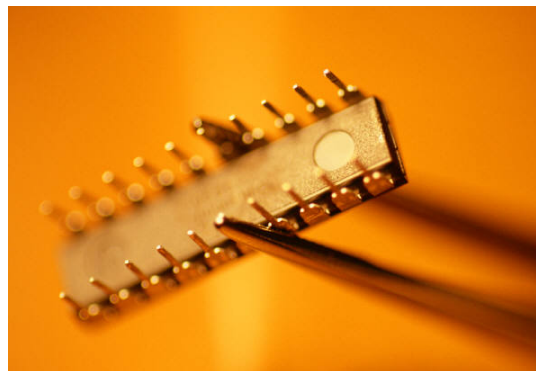
# Laminar flow box

## When working in a laminar flow box?

- Need of a sterile atmosphere
  - often biological work
  - biosafety cabinets
- Need of a dust free atmosphere
  - optics
  - analytics
  - electronics

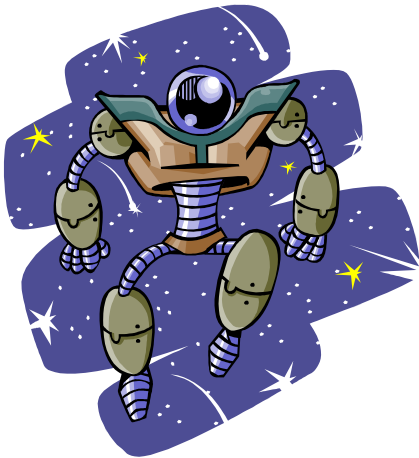


source: <http://zocker0815.npage.de/gedanken.html>



# Acids and Bases

- $\text{HCl}$
- $\text{HNO}_3$
- $\text{H}_2\text{SO}_4$
- $\text{HF}$
- $\text{H}_3\text{CCOOH}$
- ...



- $\text{NaOH}$
- $\text{KOH}$
- $\text{Ca(OH)}_2$
- $\text{NH}_3$
- $\text{H}_3\text{CNH}_2$
- ...

# Chemical burn

*Danger:*

Acids can cause chemical burns on the skin



Model: Nitric acid on meat – with and without protective gloves



# Chemical burn

## Observations:

- The piece of meat turns immediately white when it gets in contact with the acid  
→ **chemical burn**
- The piece of meat protected by a glove isn't chemically burned
- Also the glove remains intact

## Consequences:

- Wear gloves and safety glasses
- Work in a fume hood



# Hydrofluoric acid – HF

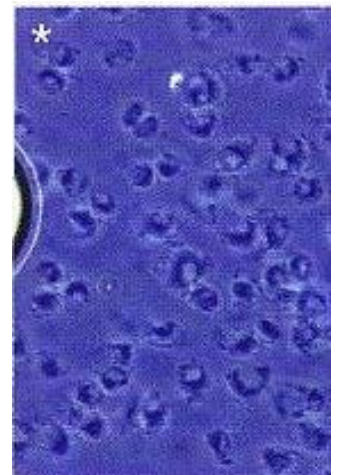
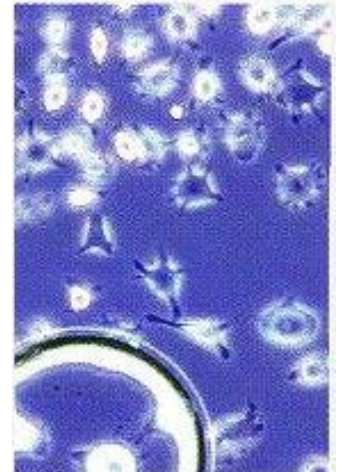
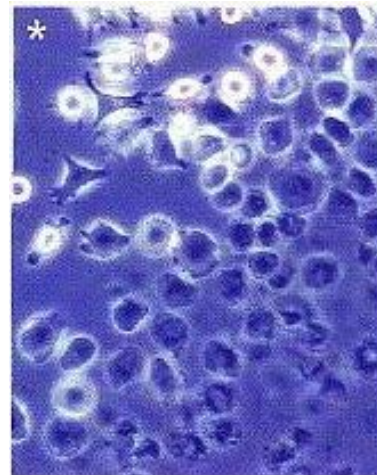
- Highly corrosive liquid
- *Strong contact poison*
- Chemical burn of lower tissue layers, even bones
- Symptoms of exposure may not be immediately evident
  - interferes with nerve function
  - initially chemical burns may not be painful
  - *accidental exposures can go unnoticed*
- As a rule: a burn the size of your palm is fatal (40% HF)



source:  
<http://www.glasmalerei.de/techniken/aetzen/aetzen-1/index.html>

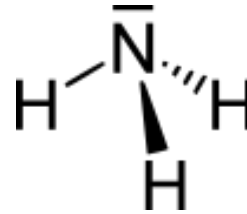
# Sodium hydroxide – NaOH

- Can decompose proteins and lipids in skin, eyes ...  
→ chemical burn
- Dissolution of solid NaOH  
→ exothermic, resulting heat can cause heat burns or ignite flammables
- Exothermic reaction with acids
- Corrosive to some metals, e.g. Al  
→ produces flammable  $H_2$  gas



# Ammonia

- Characteristic pungent smell
- Irritating, caustic effects on eyes and skin
- Easily resorbed through the skin
- Inhalation
  - irritating / harmful effects on the respiratory system (*acute effect*)
  - respiratory disorder (*chronic effect*)
- Oral incorporation
  - severe damages of the digestive tract



***Pungent smell = first warning***  
***Poisoning with ammonia occurs seldom.***

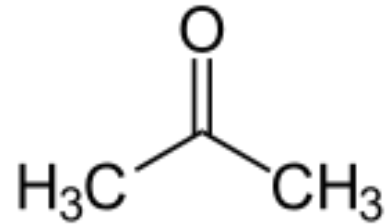
# Solvents



- acetone
- acetonitrile
- dichloromethane
- ethanol
- ethyl acetate
- hexane
- tetrahydrofuran
- ...



# Acetone



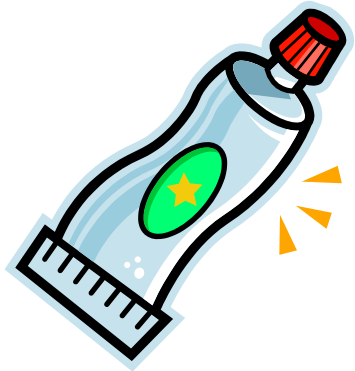
- Degreases the skin
- Only slightly toxic in normal use
- Most hazardous property: *extreme flammability*
- Temperature greater than flash point  
→ air/**acetone** mixtures (97.5/**2.5**-vol% – 87.2/**12.8**-vol%) may explode or cause a flash fire
- Vapors can ignite sources and flash back
- Static discharge may ignite acetone vapors

# Solvents

## *Danger:*

Damage of material or deleterious effects on skin

Model: Acetone on Styrofoam – with and without protective hand cream



# Solvents



## *Observations:*

- Acetone immediately attacks the Styrofoam chip
- The Styrofoam chip protected by hand cream remains almost undamaged

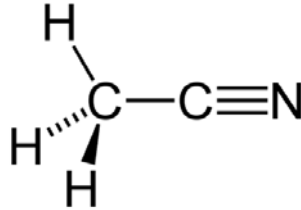
## *Consequences:*

*Skin protection and care comprises:*

- Use of hand cream
- Use of gloves



# Acetonitrile



- Metabolized to *hydrogen cyanide*  
→ the onset of toxic effects is delayed about 2–12 hours
- *Symptoms:* breathing difficulties, slow pulse rate, nausea, and vomiting

## *Serious cases:*

Convulsions and coma, followed by death from respiratory failure



source:

[http://www.topfruits.de/html\\_datasheet.php?products\\_id=1810](http://www.topfruits.de/html_datasheet.php?products_id=1810)

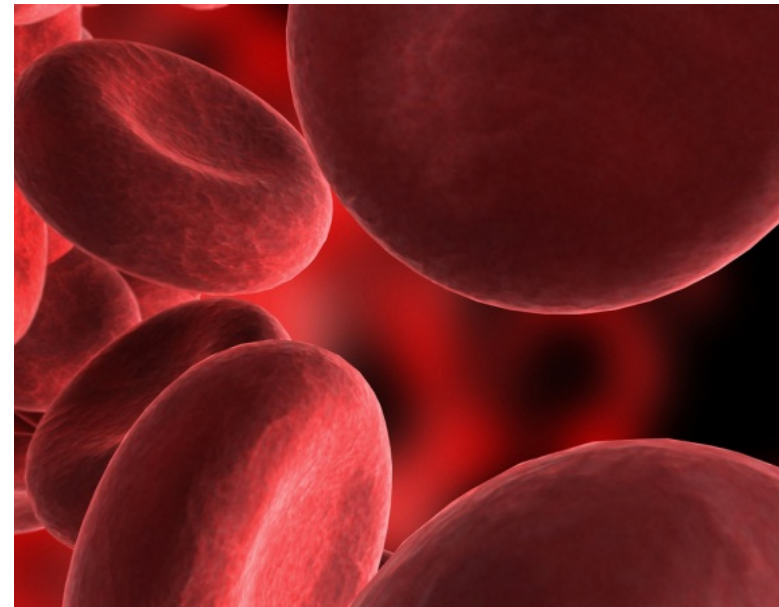
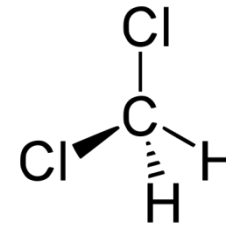


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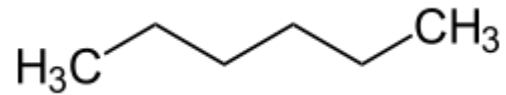
<http://www.hoio.ch/index.php?id=1103>

# Dichloromethane (DCM)

- High volatility
- *Acute inhalation hazard*
- Metabolized to carbon monoxide  
→ eventually CO poisoning
- Acute exposure by inhalation  
→ optic neuropathy, hepatitis
- Prolonged skin contact  
→ possibly dissolving of the fatty tissues in skin  
→ skin irritation or chemical burns
- DCM *might be carcinogenic*



# Hexane



- *Acute toxicity:*

Low, mild anesthetic

→ first a state of mild euphoria

→ followed by somnolence with headaches and nausea

- *Chronical toxicity:*

Well known in humans

→ Extensive peripheral nervous system failure

*Initial symptoms:* tingling, cramps in the arms and legs

*then:* general muscular weakness

- Suspected of damaging fertility



# Tetrahydrofuran (THF)

- Penetrates the skin → rapid dehydration
- Serious eye irritation
- Respiratory irritation
- Greatest danger: *tendency to form highly-explosive peroxides on storage in air*
  - often inhibitor added in commercial samples
  - THF should not be distilled to dryness, because the explosive peroxides concentrate in the residue



# Inflammable chemicals



*Danger:*

Inflammable substances can ignite or be ignited and cause fires and burns

Model: Ignition of gasoline vapors



# Inflammable chemicals



## *Observations:*

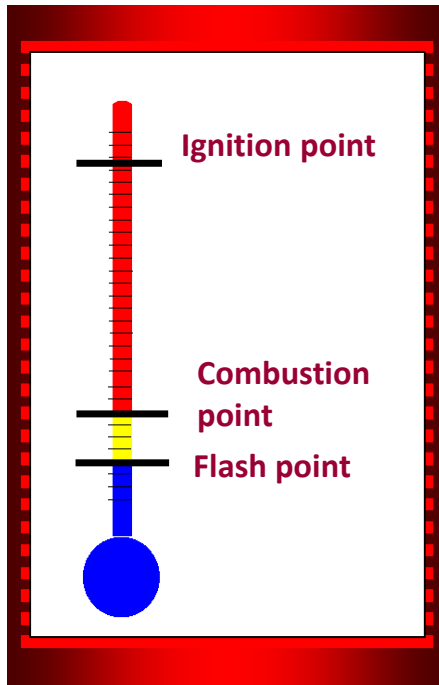


- Gasoline vapors are heavier than air  
→ burning candle ignites them
- Flame rises up the glass tube

# Inflammable chemicals



## *Explanation:*



### Flash point:

Vapors are ignited by an ignition source  
combustion stops after removal of the ignition source

Combustion point: Vapors are ignited by an ignition source  
continue burning after removal of the ignition source

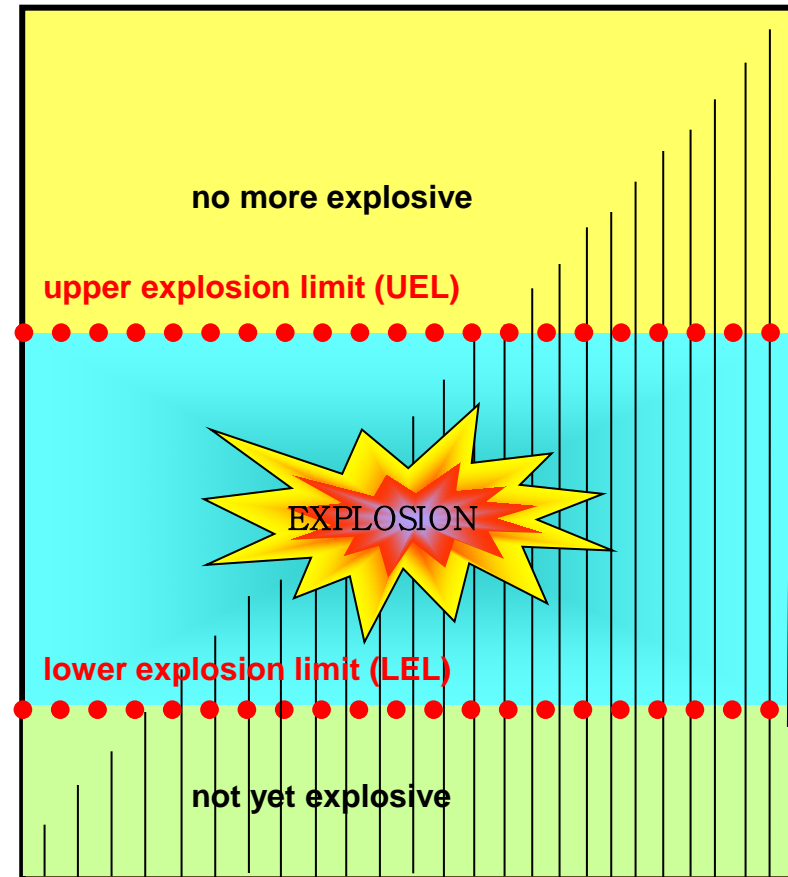
### Ignition point:

Vapors ignite spontaneously

# Inflammable chemicals

## *Explosive mixtures:*

substance	LEL [%vol]	UEL [%vol]
ether	1.7	36.0
ethanol	3.4	15.0
gasoline	0.6	8.0
hydrogen	4.0	75.6



# No smoking



# No food and drinks in a lab



# What is wrong?



# What is wrong?



# What is wrong?

Gefährliche Stoffe niemals in Getränkeflaschen!

- Gefahrenpiktogramme beachten.
- Gefährliche Stoffe in Originalverpackung aufbewahren.
- Niemals in Lebensmittelbehälter umfüllen.



**NEVER!**

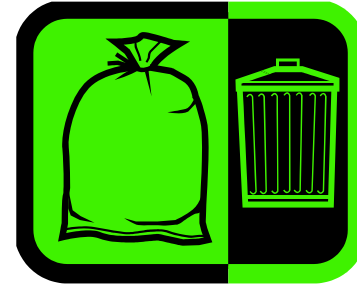
suva**pro**  
Sicher arbeiten

Suva, Postfach, 6002 Luzern, Tel. 041 419 58 51 Bestellnummer 55232.d  
Online-Bestellung: [www.suva.ch/vasaio](http://www.suva.ch/vasaio)



# Disposal of “normal” waste

- Minimize waste
- Separate waste
  - Paper and cardboard
  - Glass and bottles
  - PET
  - Metal
  - Electrical waste
  - Used CD/DVDs



# Disposal of hazardous waste

- Minimize waste
- Use official containers
- Separate waste
  - Acids
  - Bases
  - Mercury
  - Chlorinated solvents
  - Non-chlorinated solvents
  - ...

→ The smellier the waste the more it needs to be collected separately



# Disposal of hazardous waste

- CNB E 146  
Wednesday: 9 - 11 am  
Contact: **Martin Frei** (martin-frei@ethz.ch)
- HCI D 276  
Monday - Friday: 2 - 4 pm  
Contact: **Guido Krucker** (guido-krucker@ethz.ch)
- HPL D 15.2  
Each first Tuesday of the month: 9 - 11 am  
Contact: **Guido Krucker**



Campus Zentrum



Science City, Campus Hönggerberg

# Waste?



# Waste!



source: <http://sprachstammtischmuenchen.jimdo.com/blog-latest-news/all-blog-posts/>



# Apparently harmless substances: really harmless ↔ inherent dangerous

## Example 1: Nitrogen ( $N_2$ )

- The air consists of almost 80% nitrogen
- Nitrogen is not flammable, not toxic, odorless

→ absolutely harmless???



source: BG RCI

# Liquid nitrogen

*Danger:*

Apparently harmless substances

→ Risk is underestimated

Model: Rose in liquid nitrogen



# Liquid nitrogen

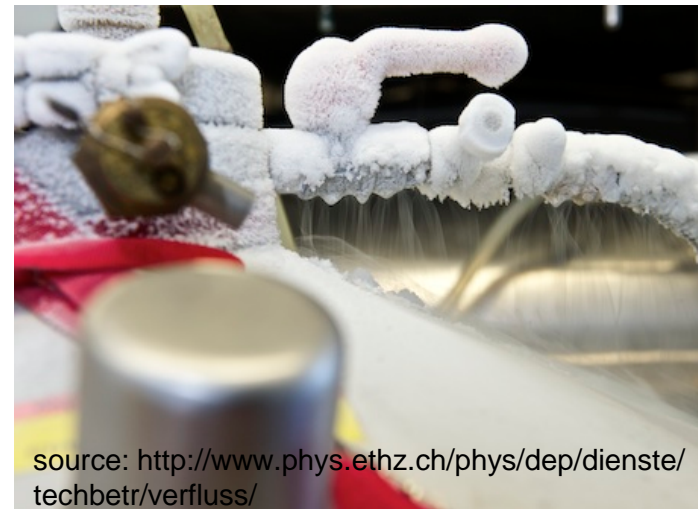


## Observations:

- The rose cracks after removal from the liquid nitrogen bath ( $-196\text{ }^{\circ}\text{C}$ )
- Even very cold substances can be liquid → cryogenic liquids

## Consequences:

- Avoid direct contact to cryogenics (also to tubing)
- Wear safety glasses and special gloves



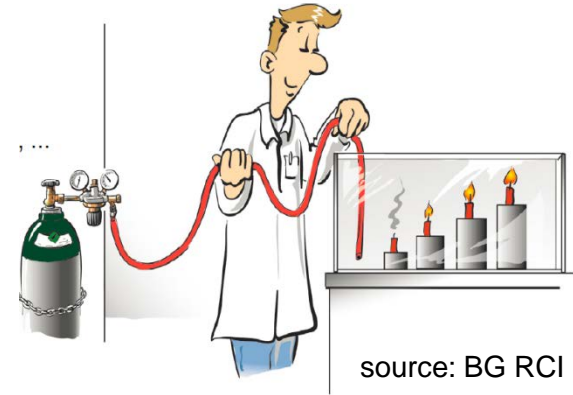
source: <http://www.phys.ethz.ch/phys/dep/dienste/techbetr/verfluss/>

➔ SSHE seminar “Cryogenics and gas cylinders”

# Liquid nitrogen

## *Yet another danger:*

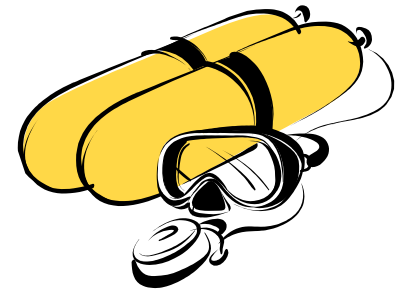
- 1 Liter of liquid nitrogen  
→ about 700 liter of gas!
- Displaces oxygen ( $O_2$ ) from the air



content of $O_2$ in the air	What happens?
ca. 21%	Normal ambient air
< 16%	Expired air Loss of performance
< 11%	Fire gets extinguished
< 10%	Sudden loss of consciousness
< 6-8%	Death by asphyxiation within minutes

# Apparently harmless substances: really harmless ↔ inherent dangerous

## Example 2: Compressed Air



„Compressed air is not really dangerous, is it?“



# Gas cylinders



*Danger:*

Underestimation of „secondary“ hazards

Model: Valve of compressed air cylinder breaks



source: Schweizerischer Feuerwehrverband

# Gas cylinders

## *Consequences:*

- → Use personal protective equipment
- → Avoid heat sources next to gas cylinders
- → Secure gas cylinders against falling
- → Always use the correct pressure reducing valve
- → When not in use: safety cap
- → Never use „brute-force“ when handling valves
- → Never lubricate valves
- → Label empty and defective cylinders



➔ *SSHE seminar “Cryogenics and gas cylinders”*

# What's wrong?



source: BG RCI

# What's wrong?



source: BG RCI

# How to store gas cylinders in a laboratory



Coffee break



# MAIN HAZARDS (II): PHYSICAL HAZARDS ETC.



## Other common hazards in a (chemical) lab:

- *Lasers*
- *Heat sources*
- *Magnetic fields*
- Biological agents (pathogens, GMO)
- Centrifuges
- High voltage, power current
- *Vacuum or high pressure*
- *Sharps and glassware*
- ...



# Laser (*non-ionising radiation*)

## 4 Classes:

- **Class 1**
  - Safe under all conditions of normal use
- **Class 2**
  - Visible-light lasers
  - Fairly safe  
blink reflex will limit the exposure to no more than 0.25 seconds (if not viewed through optical instruments)  
*Do not stare into beam*



# Laser (*non-ionising radiation*)



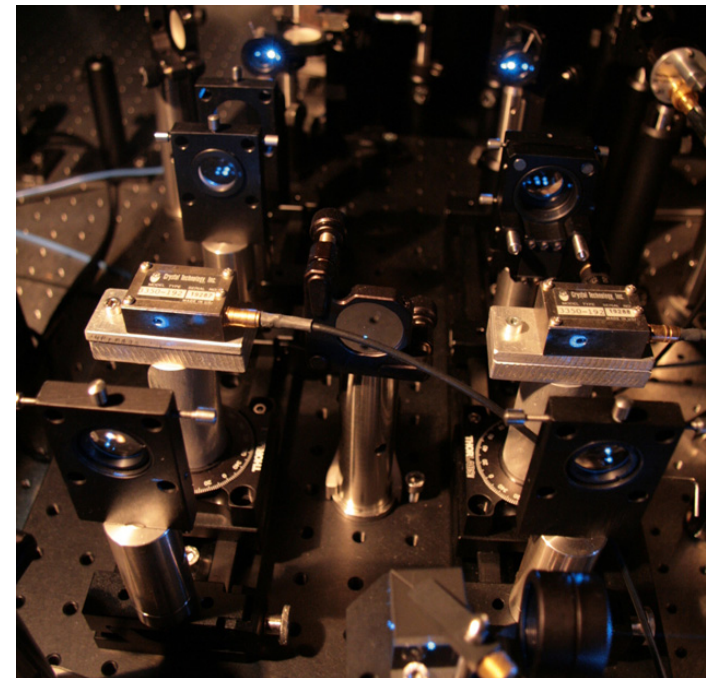
## Class 3 R

- Is considered safe if handled carefully, with restricted beam viewing
- The maximum permissible exposure can be exceeded  
→ low risk of injury

## Class 3 B

- **Hazardous** if the eye is exposed directly, in some cases it can be hazardous for the skin

*Wear protective eyewear*



source : [www.dresden-forscht.de/index.php?id=49](http://www.dresden-forscht.de/index.php?id=49)

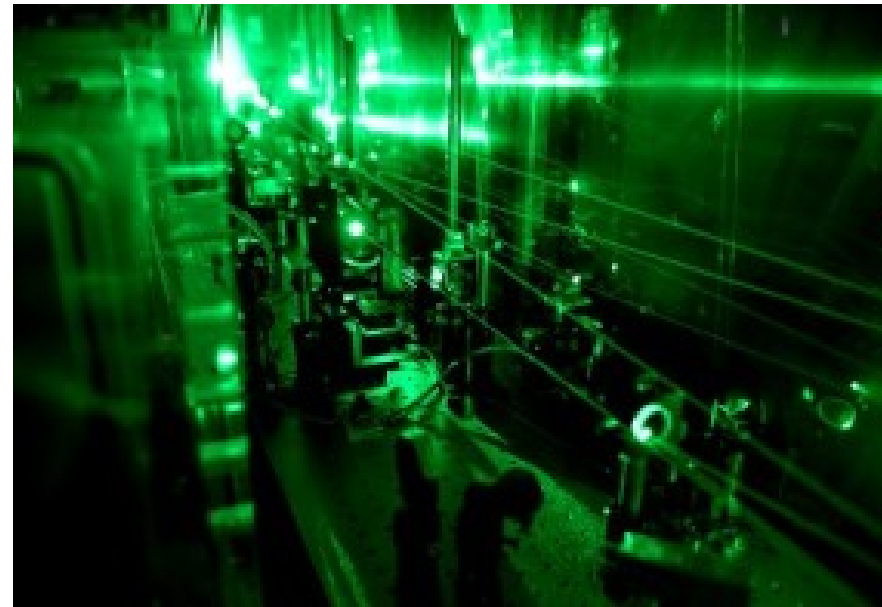
# Laser (*non-ionising radiation*)



## Class 4

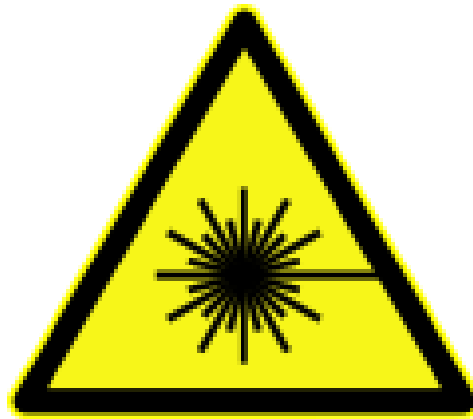
- Can cause **permanent eye damage** and **burn** the **skin** as a result of direct or diffuse beam viewing.
- May ignite combustible materials, and thus may represent a **fire or explosion risk**

*Wear protective eyewear*



# Laser Labelling

Warning sign



Indication of laser class  
and instructions



# Additional labelling – laser classes 3B and 4

## Laser data



Warning lamp  
in front of the door  
=  
***DON`T ENTER.***

Laser medium	
Wave length	
Duration of emission	
Radiation efficiency	
Radiation energy	



source: <http://www.goebel-laser.de/html/warnen.html>



source: <http://www.laser2000.de/index.php?id=370356>

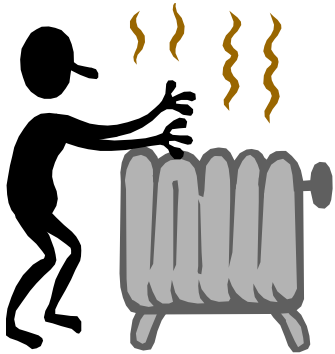
# Heat sources in a lab



- open fire (Bunsen burner)
- hotplate
- sand bath
- oil bath
- light sources (Lasers, light bulbs)
- ...



# Heat sources in a lab



## Basic rules:

- Don't touch hot surfaces  
(this rule seems to be quite obvious but...)
- Hot surfaces look the same as cold surfaces  
→ mark them with a warning sign
- Check electric installation  
(temperature control, etc.)  
regularly



source: [www.semadeni.com](http://www.semadeni.com)

# Heat sources in a lab



## Some more rules:

- Caution: no water near oil bathes!  
→ preferably use DrySyn systems
- Keep flammables and gas cylinders away from heat sources
- Beware of secondary hazards (e.g. Laser beam, open gas,...)

source: [http://www.dechema.de/Presse/Pressemitteilungen/Archiv/2008/42\\_2008.html](http://www.dechema.de/Presse/Pressemitteilungen/Archiv/2008/42_2008.html)

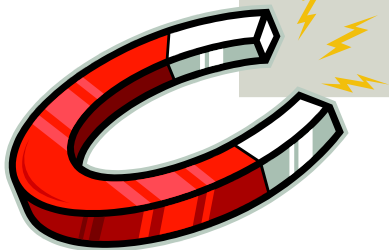


# Magnetic fields

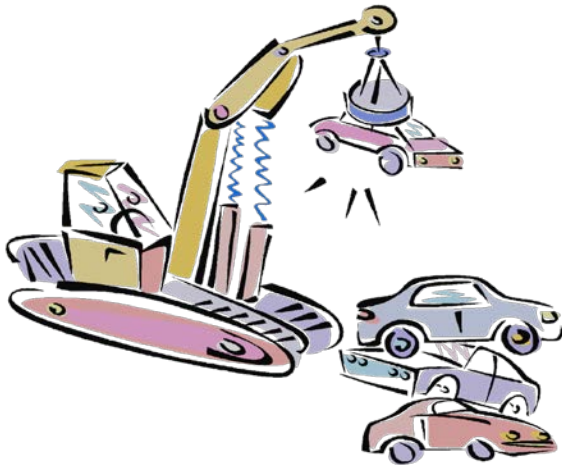


Hazardous effect depends on the strength of the magnetic field

Field intensity	description	Restrictions / no access for
0.5 mT / 5 G	Maximal field authorized for public, wearers of pacemakers or implants, pregnant women	Public, wearers of pacemakers or implants, pregnant women
3 mT / 30 G	Field starting from which ferromagnetic objects can be dragged by the field	Any ferromagnetic object (e.g. tools)
0.2 T / 2 kG	Field starting from which the access is unauthorized without medical recommendation.	Any, except with medical recommendation



# Magnetic fields

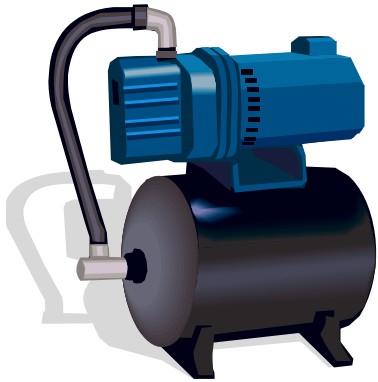


## Protective measures

- Mark the dangerous zone (line on the ground)
- Keep out if you are not authorized
- Warning signs, prohibitions



# Vacuum



- Implosion
- Protective measures:  
shielding windows, safety glasses, etc.
- Never evacuate cylindrical or cubic glassware  
(only round flasks)
- Make sure that equipment is  
vacuum-proof



# High pressure



- **Explosion**
- Hazard depends on physical condition: 200 bar liquid (e.g. HPLC) less hazardous than 200 bar gas pressure (e.g. N<sub>2</sub> gas bottle)
- Make sure that equipment is high-pressure-proof
- Reactions / procedures with more than 10 bar gas pressure
  - **work in high pressure labs**
  - **inform SSHE**



# Sharps



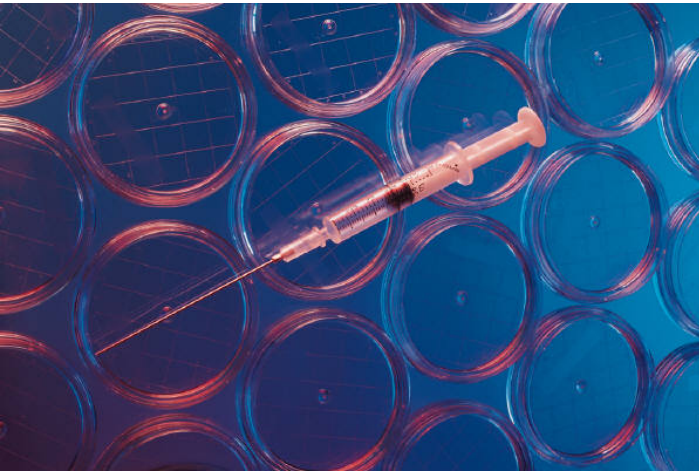
- **Sharps**  
Syringe needles, scalpels  
→ Replace sharps if possible
- **Injuries**  
Potential source of contamination with chemical, biological, infectious, radioactive material
- **Needle-stick injuries**  
Often occur when recapping needles  
→ Never recap syringe needles; immediately dispose of syringe and needle  
→ Never place any sharps in the ordinary trash bin
- **Common causes for lacerations**  
→ Picking up contaminated pieces of broken glassware  
→ Working with damaged glass equipment

# Special sharp containers

- Always use a properly labeled, special sharps container (unbreakable, puncture-proof, sealable)
- Place sharps container within easy reach
- Don't walk around when carrying sharps
- Dispose of sharps immediately after use
- Don't overfill sharps container
- Seal it when it is  $\frac{3}{4}$  full and take it to the hazardous waste disposal station



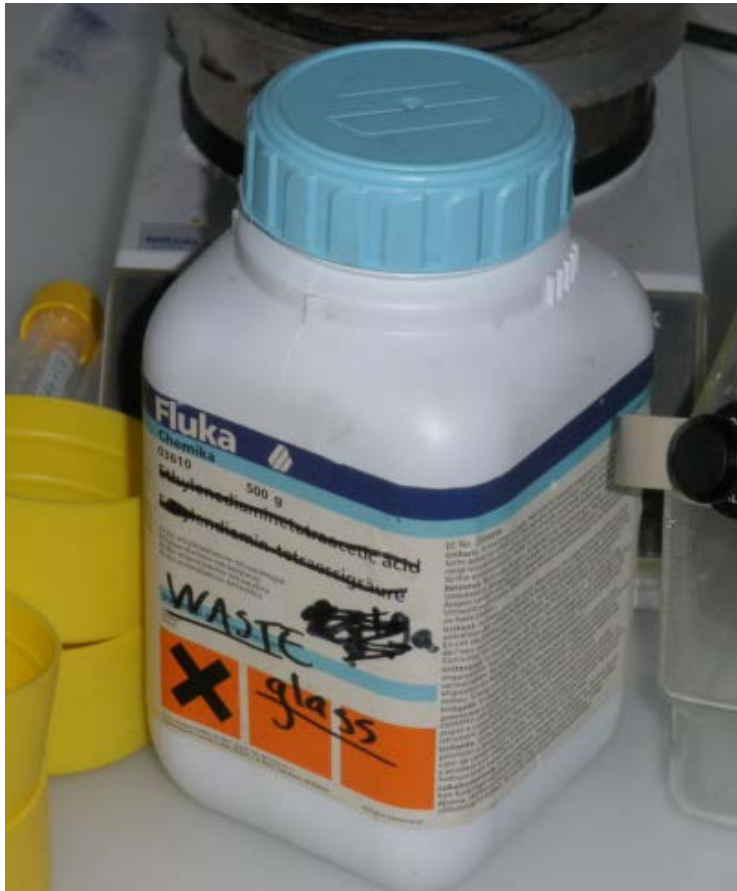
# Sharps contaminated with infectious material



Have to be inactivated before disposal

- collect in autoclavable sharps containers
- autoclave
- dispose

# What is wrong?



# If even apparently harmless substances and processes can carry inherent dangers, how can I know...

- ... which substances and processes are harmless and which ones are not?
- ... which kind of dangers play a role with which substances?
- ... where to find further information?
- ... how to protect me and others from these dangers?



# **RISK IDENTIFICATION – WHERE TO FIND INFORMATION?**



# Where to find information on specific hazards



- Machines / equipment  
→ user's manual, supplier
- Laboratory hazards  
→ ETH safety manual  
(new version under construction)  
→ DGUV “Working Safely in Laboratories – Basic Principles and Guidelines”  
<http://bgi850-0.vur.jedermann.de/index.jsp>  
  
→ ETH SSHE factsheets, guidelines, concepts  
<http://www.sicherheit.ethz.ch/docs/index>



# Where to find information on chemicals

- On the **product label** on the bottle / can
- In the **MSDS** (**M**aterial **S**afety **D**ata **S**heet)
  - Substance, production company
  - Detailed contents
  - Possible hazards
  - First aid measures
  - Fire fighting measures
  - Handling and storing
  - Personal protective equipment (PPE)
  - Physical and chemical properties
  - Toxicology
  - Ecotoxicology
  - Transportation
  - Legal aspects

# Where to find information on chemicals



- | Online databases  
→ e.g. GESTIS (also available as Apple and Android app)
- | For non-commercial new chemicals: scientific publications (sometimes

# DEALING WITH HAZARDS – SAFETY MEASURES

# Dealing with hazards / minimization of risks

## Before the experiment:

- Check and consider safety instructions
- Define exactly the work flow and procedures
- Check experimental setup



# Minimization of risks



During the experiment:



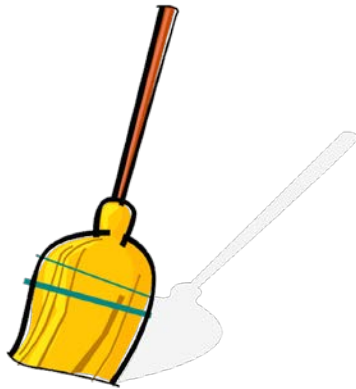
- Apply safety measures
- Use protective equipment
- Protect people, environment and values



# Minimization of risks

## After the experiment

- Clean up your workplace, sort / recycle your waste
- Turn off all media (cooling water, electricity, gas, etc.)



**In general: think  
before you act**

**In case of doubts  
or questions:  
contact an  
expert**

# Dealing with hazards: The STOP concept

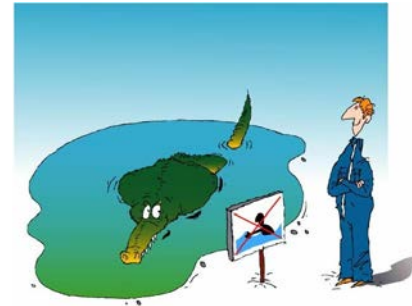


**T**echnical  
measures

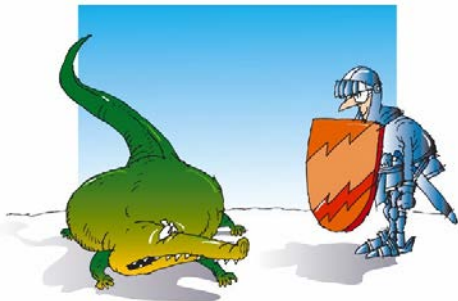
**S**trategic  
measures



**O**rganizational  
measures



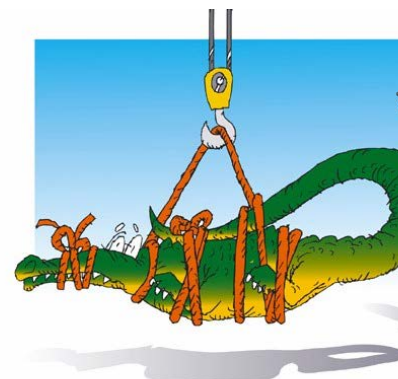
**P**ersonal  
protective  
equipment



Decreasing efficacy

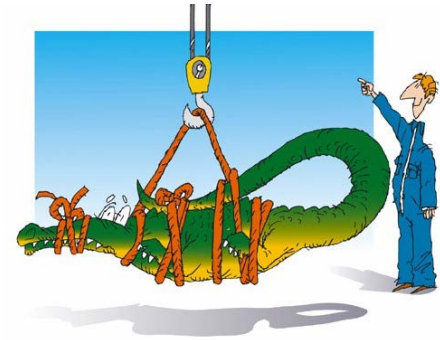
## STOP: Strategic measures

- Check if there are less hazardous products available (substitution)  
→ e.g. heptane or pentane instead of hexane
- Check for safer procedures  
→ e.g. “DrySyn” instead of oil bath



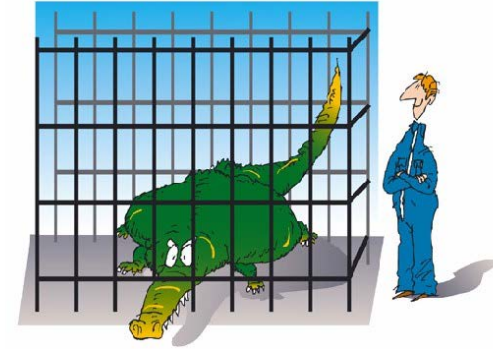
## STOP: Strategic measures

- Check for “hidden” / secondary hazards  
→ e.g. laser class 4: produces not only light, but might also cause fire
- Preferably use small quantities of chemicals  
→ e.g. small-scale reactions; large scale only with optimized parameters



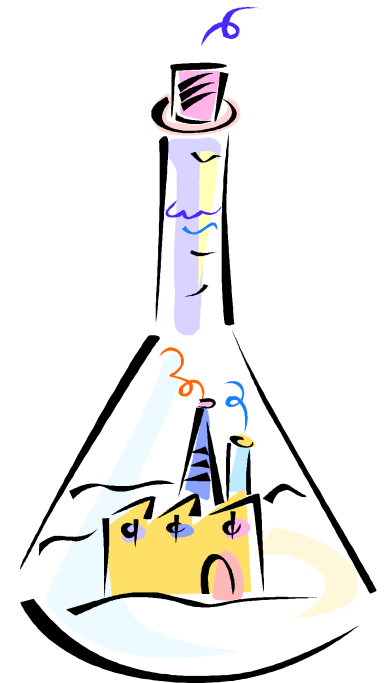
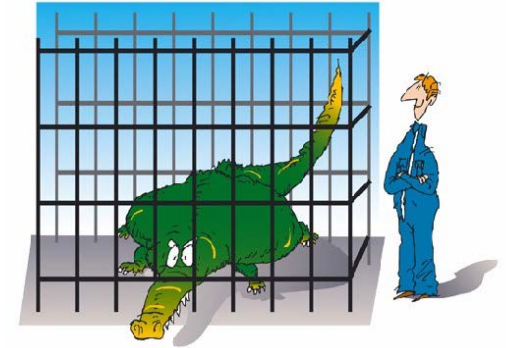
## STOP: Technical measures

- Separate work areas  
→ some work (e.g. radioactivity, biohazard) need special labs
- Gas detection  
→ when working with hazardous gases or liq. N<sub>2</sub> (depending on quantity)  
→ contact SSHE



## STOP: Technical measures

- Shielding
  - e.g. shatter protection shields, lead shields for gamma-radiation
- Ventilation / fume hood / local exhaust ventilations
  - no hazardous work in non-ventilated areas
  - handling harmful chemicals, soldering

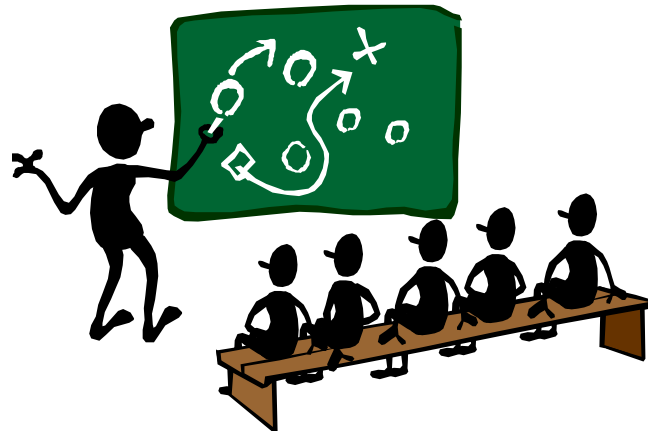


# STOP: Organisational measures



## *Instruction / training / SOP's*

- Mandatory (supervisor is responsible for instruction / training, employees have to work according to them)
- Also for students, visitors, maintenance personnel, etc.
- Set up SOP's for specific procedures



# STOP: Organisational measures

## Labels / signs

- Hazard symbols, warning signs, obligations, access restriction (available from the SSHE)
- Employees have to know what they mean and how to behave
- Use signs when necessary **but never warn of non-existing hazards!**



Zutritt nur für berechtigte Personen  
Accès réservé aux personnes autorisées  
Accesso riservato alle persone autorizzate  
Authorized entrances only



# Lab safety – some general rules

- Entrance only for people working in the lab
- No food and drinks in the lab
- Disorder amplifies the risk → keep your working area clean
- Never do risky work alone → there must always be a second person in the same room
- „Hot things often look the same as cold things“ → be careful
- Experiments running over night → secure all media (cooling water, etc.)



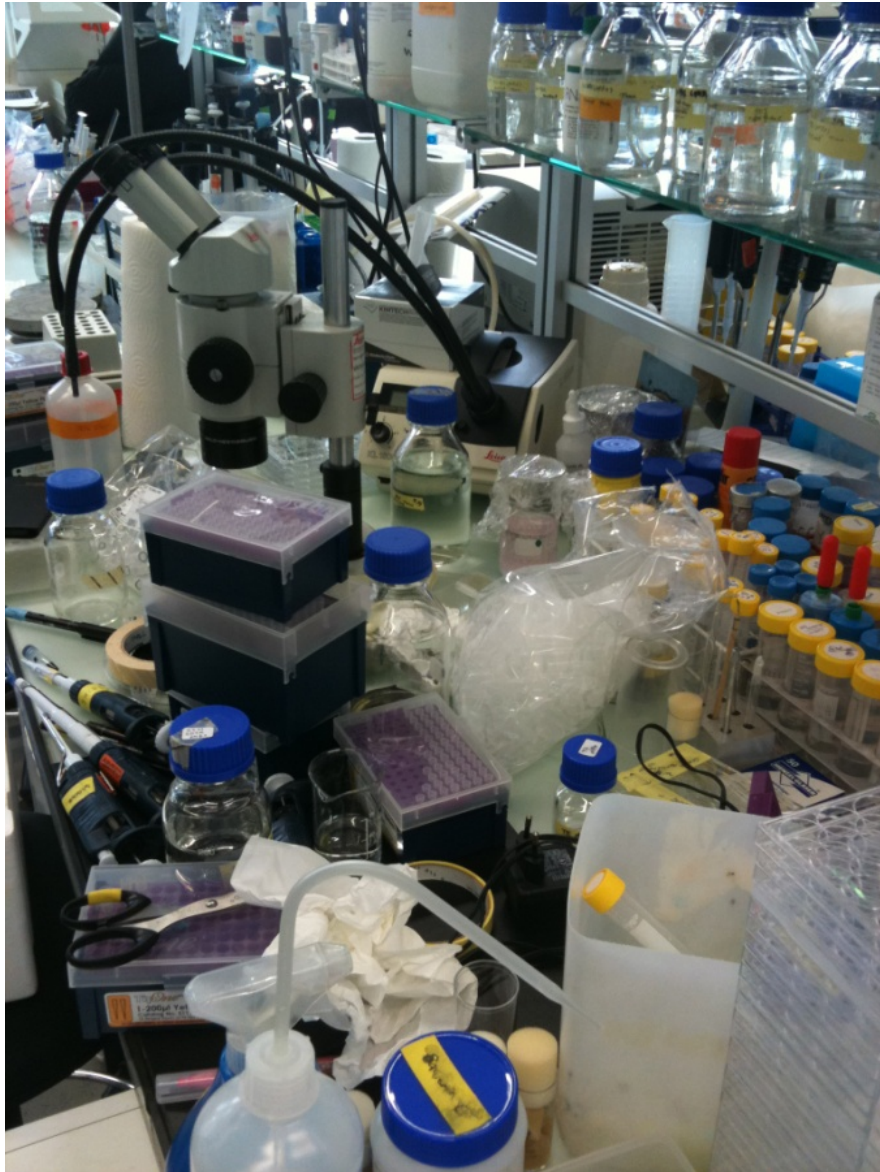
source: [http://nobel.scas.bcit.ca/debeck\\_pt/science/safety.htm](http://nobel.scas.bcit.ca/debeck_pt/science/safety.htm)

# Lab safety – some more rules

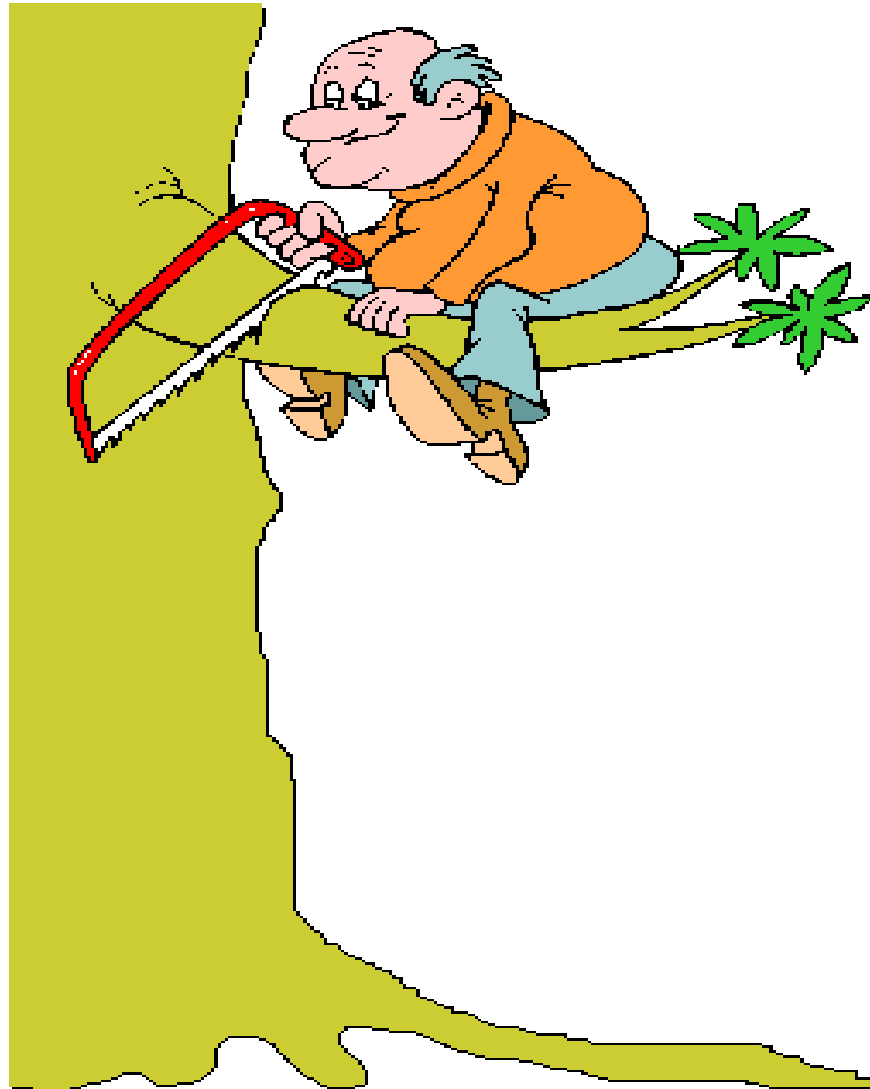


- Wear appropriate clothing  
→ long trousers, robust and closed shoes
- Wear appropriate PPE (safety glasses, lab coat, etc.)

# Disorder amplifies the risk



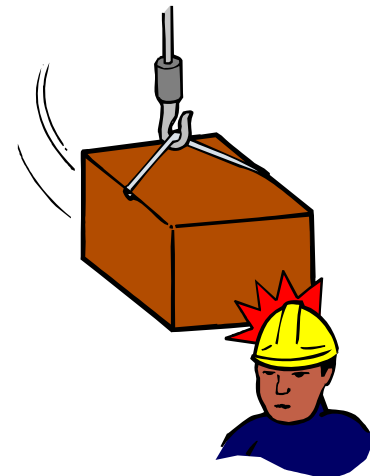
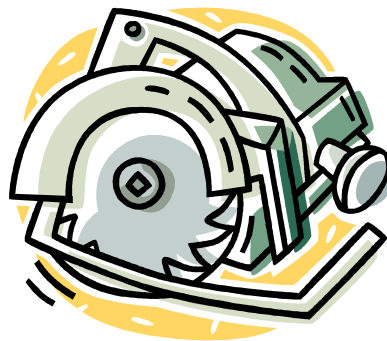
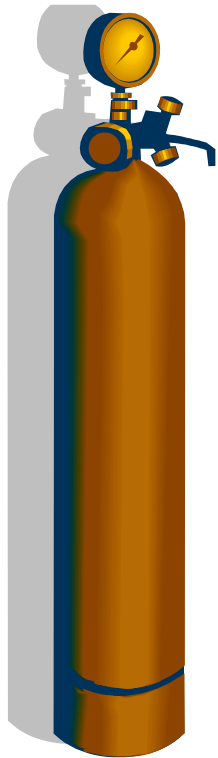
# Risky work



# Never do risky work alone



source: <http://de.wikipedia.org/>














# Overnight

Nachttafel / Overnight Experiment

Stab SGU, ETH Zürich

## Nachttafel für Experimente / Overnight Experiments

Gebäude und Raumnummer / Building and room number: \_\_\_\_\_

Datum und Uhrzeit <i>date and time</i>												
Beginn <i>start</i>							Ende <i>end</i>					
Verantwortliche Person und Stellvertreter <i>responsible person and deputy</i>												
Name <i>name</i>							private Telefonnummer <i>private phone number</i>					
Name <i>name</i>							private Telefonnummer <i>private phone number</i>					
Experiment / Reaktion <i>experiment / reaction</i>												
Beschreibung <i>description</i>												
Reaktionsgleichung <i>chemical equation</i>												
Lösemittel <i>solvents</i>												
Medien <i>media</i>	<input type="checkbox"/> Elektrizität <i>electricity</i>		<input type="checkbox"/> Kühlwasser <i>cooling water</i>		<input type="checkbox"/> Stickstoff <i>nitrogen</i>		<input type="checkbox"/> Vakuum <i>vacuum</i>		<input type="checkbox"/> sonstiges: <i>other:</i>			
Spezielle Gefahren <i>Particular hazards</i>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	 <input type="checkbox"/>	
Geeignete Löschmittel <i>Suitable extinguishing agents</i>	<input type="checkbox"/> Wasser <i>Water</i>				<input type="checkbox"/> Kohlendioxid (CO <sub>2</sub> ) <i>carbon dioxide (CO<sub>2</sub>)</i>				<input type="checkbox"/> Sand <i>sand</i>			
Notfallmassnahmen <i>Emergency measures</i>												

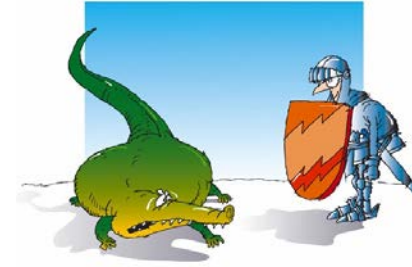
Datum und Unterschrift / *date and signature:* \_\_\_\_\_

Coffee break

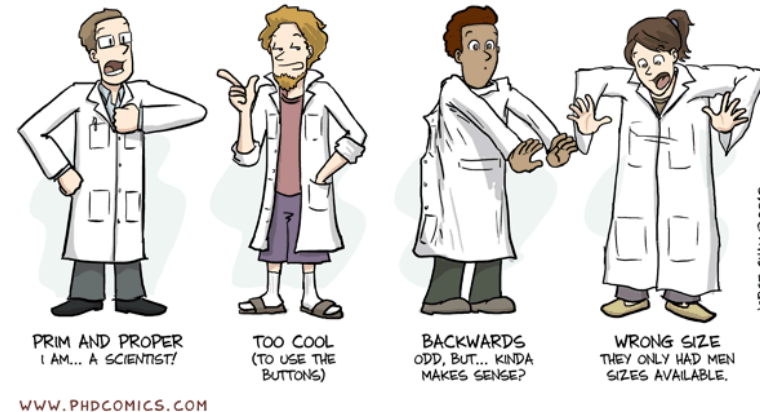


# STOP: Personal protective equipment – Lab coats

- Protection of lab personnel, environment and samples
- Mandatory in all (micro-) biological and chemical labs and when handling hazardous substances (e.g. liq. N<sub>2</sub>, special waste, etc.)
- Not allowed:  
at desk, in cafeteria, in offices, etc.
- To be washed regularly  
(for laundry service:  
contact SSHE)



LAB COAT STYLES

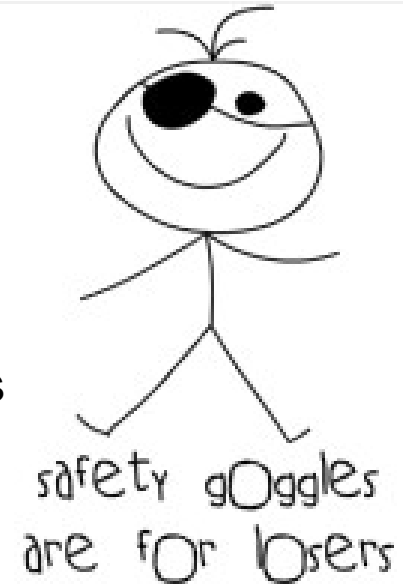


- In biosafety labs level 2:  
disinfect after contamination



# Safety goggles

- Protection of lab personnel
- Mandatory when
  - Risk of splashes / aerosol production / dust production
  - Spill cleanup
  - Handling chemicals (including solvents) or cryogenic liquids
  - Working with lasers (class 3B and 4)
  - Cutting glass
- Don't wear contact lenses (not even in combination with safety goggles)



→ **When 1 person is doing such work in the lab, all others must wear safety goggles, too!**

# Safety goggles



- Optically corrected safety glasses can be obtained via SSHE
- **Normal glasses don't replace safety goggles!**



# Gloves



- Protection of lab personnel, environment and samples
- Regularly check and replace re-usable gloves, never re-use single-use gloves
- Mandatory when
  - contact with hazardous substances or pathogenic material cannot be excluded
  - handling cryogenic liquids (liquid N<sub>2</sub> etc.) or dry ice



**Replace gloves after max. 2 h,  
wash hands and use hand cream**



# Gloves

- To be removed before
  - Working at desk / office space
  - Touching computer keyboards
  - Touching door handles, telephones, etc.
  - Leaving the lab
- Chose the appropriate glove for your work (wrong gloves → you're not safe at all!), check compatibility

What! It is only a widely spread superstition that a "latex-skin" of 0.1 mm protects me against chemicals as reliably as against infections???!!



# Which glove is the best?

Bad news: the one and only perfect glove does not exist!!!



Good news: there are suitable gloves for almost every kind of chemicals  
- It all depends on which substances you work with...



Be careful with latex / natural rubber (NR) gloves: they can cause severe allergies → not recommended!

# How to find suitable gloves

DIN/EN 374



**Degradation:** Resistance, swelling

**Penetration:** Macroscopic penetration via seams, holes

**Permeation:** Molecular penetration of gloves  
breakthrough time (min – h)

# Certification of gloves

EN 374-3



	Test substance	Compound class
<b>A</b>	Methanol	Primary alcohols
<b>B</b>	Acetone	Ketones
<b>C</b>	Acetonitrile	Organic nitriles
<b>D</b>	Dichlormethane	Chlorinated paraffines
<b>E</b>	Carbon disulfide	Sulfur containing organic compounds
<b>F</b>	Toluene	Aromatic hydrocarbons
<b>G</b>	Diethylamine	Amines
<b>H</b>	Tetrahydrofurane	Heterocycles and ethers
<b>I</b>	Ethylacetate	Esters
<b>J</b>	n-Heptane	Aliphatic hydrocarbons
<b>K</b>	Sodium hydroxide, 40%	Inorganic bases
<b>L</b>	Sulfuric acid, 96 %	Mineral acids

# Certification of gloves

## Protective level according to DIN EN 374-1:

breakthrough time

class	<b>1</b>	> 10 min
class	<b>2</b>	> 30 min
class	<b>3</b>	> 60 min
class	<b>4</b>	> 120 min
class	<b>5</b>	> 240 min
class	<b>6</b>	> 480 min



source: <http://www.mercateo.com/>

protective level of at least class 2 reached by 3 of the 12 test substances  
→ glove is deemed to be resistant against chemicals

Substance	Breakthrough time							
	Level 1 >	10 min	Level 2 >	30 min	Level 3 >	60 min		
	Level 4 >	120 min	Level 5 >	240 min	Level 6 >	480 min		
	Latex	Latex	Nitrile	Chloroprene	Butyl-cautchouk	Viton ®	PVC	PVA
Acetaldehyde	0	k.E.	0	1	6	0	0	0
Acetone	1	k.E.	0	1	6	0	k.E.	k.E.
Acetonitrile	1	k.E.	0	2	6	1	6	5
H <sub>2</sub> SO <sub>4</sub> , 25%	6	6	6	6	6	6	k.E.	0
Formic acid, 98 %	3	1	1	4	6	6	1	0
Ammonia, 25 %	1	1	5	3	6	6	k.E.	0
Amyl alcohol	3	2	6	5	6	6	k.E.	5
Benzene	0	k.E.	1	1	1	6	0	6
Butyl alcohol	2	1	6	4	6	6	6	3
Chloroform	0	k.E.	0	0	1	6	0	6
Cyclohexane	1	k.E.	6	1	2	6	6	5
Dichlormethane	0	k.E.	0	0	1	4	0	6
Diesel fuel	2	k.E.	6	4	5	6	k.E.	6
Diethyl ether	0	k.E.	2	0	1	2	0	6

Quelle: <http://userpage.chemie.fu-berlin.de/~tlehmann/handschuh.html>

# Sources of information

- Material safety data sheet (MSDS)
- Gestis database
- <http://www.ansell.be>
- <http://kcl.de>
- <http://www.arbeitssicherheit-brose.de>

# Acetone (MSDS) – protection of hands

Wear protective gloves



## Material of gloves

Butylcaoutchouc, thickness: 0,7 mm

The selection of the suitable gloves does not only depend on the material, but also on further marks of quality and varies from manufacturer to manufacturer.

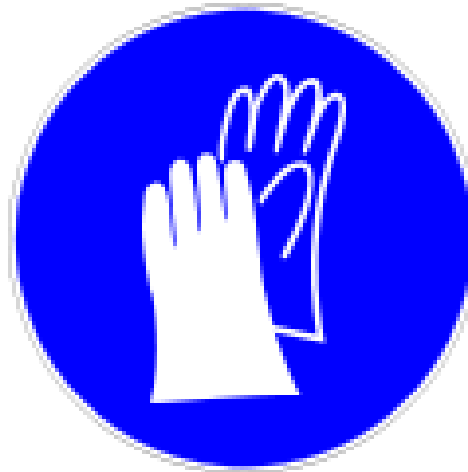
## Penetration time of glove material

Value for the permeation: Level  $\geq 6$

The exact breakthrough time has to be found out by the manufacturer of the protective gloves and has to be observed.

As protection from splashes gloves made of the following materials are suitable: Natural rubber

# How to remove gloves



# Respiratory protection:

**Respirators** (gas filters)

VS.



**Dust mask** (particle filters)





# Respirators



## Some basics:

- Mandatory when risk of toxic gases or chemical vapors / smoke
- All potentially exposed people have to wear one
- 2 Types:
  - Dependent on circulating air
  - Independent of circulating air



# Respirators



Masks dependent on circulating air:

- (A) Full face masks
- (B) Half masks



source: <http://www.pps-vertrieb.de/maske-sfera-silikon-vollmaske.html>



source:  
<http://www.ace-markenshop.com>



source: <http://www.ritz-arbeitsschutz.de/industrie/atemschutzmasken/halbmasken/index.html>



source: <http://www.schutzbusshop.de/Moldex-Halbmasken-Set-8982-mit-A1B1E1K1-P3-R-D-Filter>



# Dust Masks



## Some basics:

- Mandatory when risk of hazardous dusts / aerosols
- All potentially exposed people have to wear one
- Doesn't protect against chemical vapors or toxic gases
- Doesn't protect against lack of oxygen
- **Doesn't replace a fume hood!**
- **Surgical masks  $\neq$  dust masks!**



www.shutterstock.com - 10370572

# Dust Masks



Surgical face mask (*no FFP class*)

## Filter classes:

3 classes according to European standard EN149:2001(2009)

Filter class	Penetration limit (@95L/min air flow)	Inward leakage rate
FFP1	> 80%	< 22%
FFP2	> 94%	< 8%
FFP3	> 99%	< 2%

**Make sure the dust mask suits you**  
(not only filter class is important)



FFP 3: different mask types

# EMERGENCIES/ ACCIDENTS

# What to do in case of an accident?

- First-aid zip bags
- Eye showers
- Emergency showers
- ETH first aid team



## Unfall – was tun? Accident – how to react?

1. Verletzungsart > Alarmieren Kind of injury > Call 'S.O.S.'	immer <b>888</b> always	
Schwerer Unfall Severe accident	<b>0-144</b>	
Vergiftung Poisoning	<b>0-145</b>	
2. Nothilfe leisten (ABC,...) First Aid (ABC,...)		

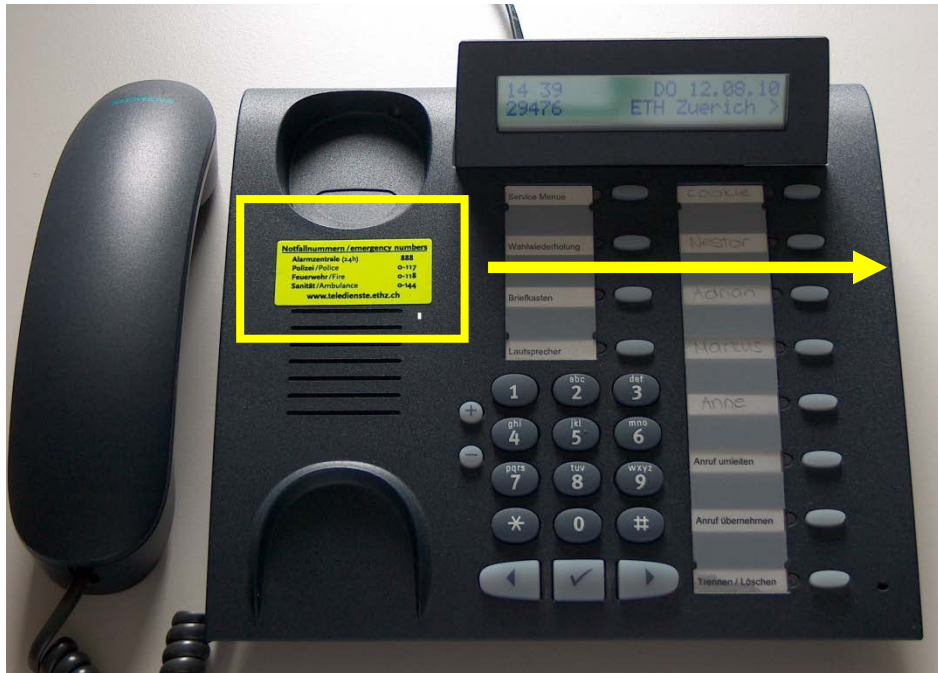
**Alle Notfälle / All emergencies: 888**

ETH Zürich, Abt. Sicherheit / [safety@su.ethz.ch](mailto:safety@su.ethz.ch) / [www.sicherheit.ethz.ch](http://www.sicherheit.ethz.ch)

# Eye showers



# Emergency numbers



ETH Alert Center  
= 24/7!

**888** (intern)

**044/ 342 11 88** (mobile or external)

External intervention

**(0)118** fire brigade

**(0)144** ambulance

**(0)117** police

Intoxication

**(0)145** Tox-Center

# How to alarm?

- Who is calling?
- What did happen?
- Where did it happen?
- When did it happen?
- Who is involved?
- How did it happen?



The plumber asks if it is sufficient when he is coming tomorrow afternoon.

# How to behave in case of a lab accident?

- **Stay calm** – make sure your brain is in gear
- Call **888** (ambulance, fire brigade, ...)
- Take safety measures for injured persons, emergency services, not directly involved persons
- Apply first aid and observe the injured person if possible
- Wait for ETH first aid team
- Give necessary information to internal and external emergency services (**but to nobody else!**)
- Do not walk around → avoid diversion of contamination
- Do not clean the area where the accident happened → might be evidence !

**The first priority is always YOUR OWN SAFETY!**



# What to do in case of fire?

- Fire button → alarm
- Fire fighting equipment in the corridors
- Extinguishers



## Feuer – was tun? Fire – how to react?

**1. Alarmieren  
Call 'S.O.S.'**



**2. Personen retten  
Rescue all people**



**3. Türen schliessen  
Close all doors**



**4. Brand bekämpfen  
Fight the fire**



**Alle Notfälle / All emergencies: 888**

ETH Zürich, Abt. Sicherheit / [safety@su.ethz.ch](mailto:safety@su.ethz.ch) / [www.sicherheit.ethz.ch](http://www.sicherheit.ethz.ch)

# Fire extinguishers



# After this seminar: are you an expert for working safely in the lab?

## → Check (or refresh your knowledge)...

- E-learning modules „Gefahr im Griff“ (SUVA) covering different subjects, e.g.
  - How to deal with risks
  - Personal protective equipment
  - Hazardous substances



[http://www.suva.ch/files/wbt\\_gefahren\\_im\\_griff/index.de.html](http://www.suva.ch/files/wbt_gefahren_im_griff/index.de.html)

# SSHE course calendar

- cryogenics and gas cylinders
- biosafety
- laser seminar
- radiation protection
- disposal of hazardous waste
- working with nanoparticles
- risk assessment / hazard analysis
- ergonomics
- fire fighting training
- ...



source: wasser-leipzig.de



**Thank you for your attention!**



# Questions?